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Biosynthesis, Characterization and Antimicrobial Activity of Copper Nano structure by Palm Trunk Extract

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Abstract: The current study describes an Eco-friendly biosynthesis of copper nano structure (Cu nano sheets) employing a palm trunk extract extract as a capping agent with copper nitrate. The product was characterized for structural, morphological and optical properties, XRD results reveal the structural characteristics of the Cu nano sheets. The results demonstrated that there is no sign of the hexagonal face and that all of the diffraction peaks are linked to the FCC structure. According to calculations, Cu nano sheets have a crystallite size of 29 nm. SEM was used to examine the surface morphology formation, and the synthesized Cu nano sheets had the shape of a layer. According to UV-visible spectroscopy, which explains the optical absorption shows a sharp absorbance with a peak at 270 nm. Using the agar well disc diffusion method, the antibacterial activity was assessed against a range of pathogens. The zone of inhibition measured 40 mm for *Staphylococcus aureus* and 50 mm for *Bacillus subtilis*.

Key words: Green synthesis, palm trunk extraction, Copper nanoparticles, Antimicrobial Activity.

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Introduction

Nanotechnology encompasses the manipulation of atoms, electrons, protons, and neutrons to get new ideas for creating materials to meet difficulties in geology, engineering, medicine, agriculture, surface science, and marine research. It has three dimensions and can reach a very small size of 100 nm (1). Various industries, such as healthcare, food, cosmetics, environmental health, biomedical science, chemical industries, medication and gene delivery, energy research, electronics, mechanics, and the space industry, could gain advantages by utilizing nanoparticles (2). There have been notable developments in the drug delivery mechanism for the treatment of inflammation, cancer (3), diabetes (4), allergies (5), infections (6), and inflammation (7). Because of their better material qualities, NPs are classified as organic, inorganic, metal, or semiconductor NPs. NPs can be created using various techniques, including chemical reactions, solid reactions, co-precipitation, sol-gel methods, microwave irradiation, etc. The several types of NPs, such as zinc, palladium, copper, iron, silver, and gold. Because Cu NPs are among the best antibacterial agents available, they could be utilized as an alternative to traditional disinfectants. On the other hand, naturally occurring bacteria may be in danger from discharged Cu NPs. Green synthesis has advanced over chemical and physical methods in recent years because it is more affordable, environmentally benign, and simple to scale up for large-scale synthesis. With this method, energy, high pressure, temperature, and hazardous substances are all eliminated (8,9). Plant-medicated nanoparticles are inexpensive, safe, and simple to prepare (10). Compared to chemical and physical methods, it discovers more benefits. Plants have been utilized in the biological technique to synthesize nanoparticles coated with plant extracts with therapeutic and cosmetic applications (11). In the past, Cu NPs were made from every part of the plant, including the stem, leaves, flowers, seeds, and fruit skin. According to this article, traditional medicine has utilized dried palm trunks to treat a variety of illnesses. The plant mostly validates the existence of previously known phytochemicals, including proteins, phenols, anthraquinones, alkaloids, terpenoids, steroids, and flavonoids(14). The present study centers on the extraction of dried palm trunks as a means to produce Cu nano structure through the hydrothermal technique. This uses green chemistry to emphasize the need for plant sources for future studies.

Materials and methods

Section of experimentation

Preparation of palm trunk extract

Approximately 20 grams of dried palm trunk are sliced into little pieces. The samples were pulverized in a mixer, and the resulting extract was used for experiments. The extract underwent centrifugation at 4000 revolutions per minute for 15 minutes. The liquid remaining after centrifugation was gathered, and 30 ml of it was transferred into a conical flask.

Synthesis of Cu NPs

After dissolving 1 M of copper nitrate in 50 ml of distilled water, 25 ml of palm trunk extract was added, and the mixture was stirred for 30 minutes at room temperature. 15 minutes later, the brown hue change was noticed. The mixes were added to a 100 ml sealed Teflon-lined container, which was heated to 190 ^{o}C and kept there for 3 hours.

Characterization

The Shimadzu UV1800 spectrophotometer was utilized to analyze UV-visible spectra in the 200-900 nm regions, which was used to verify the synthesis of silver nanoparticles (15). The sample was centrifuged at 9000 rpm for 15 minutes, dried, crushed with KBr to form a pellet, and analyzed using a Thermo Nicolet iS5 model. The average particle size and shape of the Cu NPs were determined using SEM analysis. The sample was prepared by immersing a small amount of the produced Cu NPs onto a carbon-coated grid. The additional solution was separated using blotting paper, dried, and then examined with a JEOL-JSM-5610LV SEM at a resolution of 1µm, using 15kV and 27mm. The X-ray diffraction pattern helps determine the crystalline structure. X-ray equipment (Shimadzu – XRD 6000; Japan/Shimadzu Company). The X-rays were generated using Cu-Kα radiation with a wavelength of 0.15406 nm. The system is operational at an emission current of 30 mA and a voltage of 40 KV. The sample's scan range is from (20 to 90) degrees.

Results and discussions

Patterns of XRD diffraction

The Cu NPs generated XRD diffraction patterns. The XRD patterns of Cu display three main peaks at diffraction angles of 43.3, 50.4, and 74.1, corresponding to the (111), (200), and (220) planes, respectively. This result roughly corresponds with the discoveries documented in the sources (4). The hexagonal face is missing, and all diffraction peaks are identified as belonging to the FCC structure, which roughly corresponds to the standard peaks. The Scherrer formula was utilized to calculate the mean crystallite size. Table (1) displays the anticipated peak widths of a prominent diffraction plane. The intense and slender peaks are likely caused by the Cu crystallites' selective growth on the (111) plane. Table (1) shows the dimensions of Cu NPs crystallites.

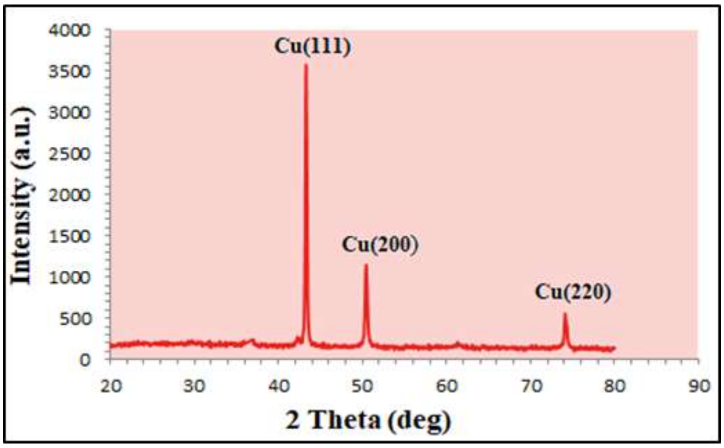

Figure (1): Shows The XRD pattern of Cu nanosheets by the palm trunk extract.

Table (1): Explain the crystallite sizes of Cu nanosheets.

Material	hkl	2 Theta (deg)	Crystallite size (nm)
Cu	111	43.3	29
	200	50.4	19
	222	74.1	29

SEM Analysis

The morphological characteristics of hydrothermally produced Cu NPs from palm trunk extract were examined using a scanning electron microscope. The synthesized Cu NPs were displayed in high density in the figure. Cu nanosheets are formed by biogenesis due to electrostatic interactions, including hydrogen bonds, bio-organic bonds, and capping molecules. As seen in Figure (2), the synthesized Cu nanosheets were stacked in shape.

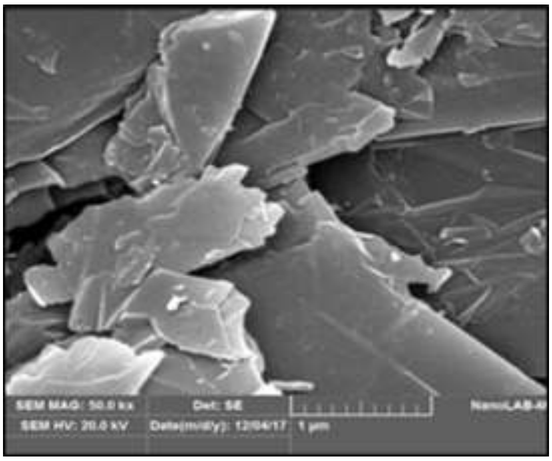

Figure (2): Shows the SEM images of Cu nanosheets by the palm trunk extract.

UV-Vis Analysis

The change in color showed that copper ions were converted into copper nanoparticles when exposed to plant extracts. The phenomenon of Surface Plasmon Resonance is responsible for the hue shift. Because the unbound electrons in the metal NPs vibrate collectively in resonance with a light wave, the metal nanoparticles exhibit an SPR absorption band. The UV-visible spectrophotometer was used to ascertain the optical properties of Cu nano sheets. after the plant extract had been mixed with copper nitrate. The absorbance of the Cu nano sheets is acute, peaking at 270 nm and gradually decreasing as the nanometer increases.

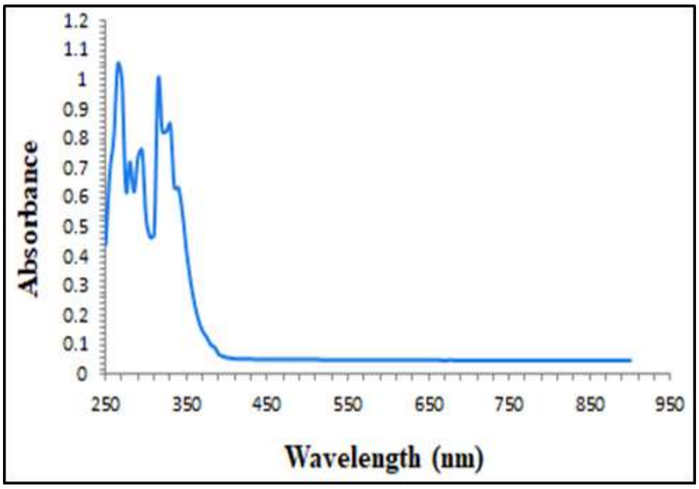

Figure (3): Shows UV-visible spectroscopic image of Cu nanosheets by the palm trunk extract.

Antimicrobial activity

Cu nanosheets were produced using a hydrothermal process using palm trunk extract, and their antibacterial properties were tested using the in vitro disc diffusion method. Both gram-negative bacteria (*Staphylococcus aureus*) and fungus (*Bacillus subtilis*) are examined, as depicted in Figure (4) and Table (2).

Figure (4): Antimicrobial activity of Cu nanosheets using the palm trunk extract.

Table (2): Antimicrobial activity of Cu NPs.

Organism	Zone of inhibition (mm) at 250 μg/ml concentration	Control
Staphylococcus aureus	40	-
Basicillus subtilis	50	-

Conclusion

Cu nanosheets were effectively synthesized using a bio-synthesis approach involving palm trunk extract. The transition from green to reddish-brown signified the creation of Copper nanoparticles. Cu NPs were detected using UV-visible spectroscopic analysis at 265 nm. The SEM analysis indicated that the particles have a layered structure. A Bioassay approach was used to evaluate the antibacterial activity. It demonstrated a more pronounced impact on inhibition. The zone of inhibition was 40 mm for *Staphylococcus aureus* and 50 mm for *Bacillus subtilis.*

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